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BEHAVIOURAL ACTIVITY, GROUP SIZE AND DIET COMPOSITION OF GELADA BABOON AT GUASSA COMMUNITY CONSERVATION AREA, NORTH SHOA ZONE, ETHIOPIA

MSc Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Biology

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LIST OF ABBREVATION AND ACRONMYS

AMU: All Male Unit system

EWCO: Ethiopian Wild life Conservation Organization

FZS: Frankfurt Zoological Society

GCCA: Guassa Community Conservation Area

NFEP: Nomination Form for the Equatorial prize

NYZS: New York Zoological Society

OMU: One Male Unit system

UNESCO: The United Nations Educational Scientific and Cultural Organization

WVE: World Vision Ethiopia

ABSTRACT

A study on the behavioural activities, group size and diet composition of gelada baboon (*Theropithecus gelada*) was conducted from August to November 2017 at Guassa Community Conservation Area (GCCA). Data were collected through direct observation of the study populations (both one male units OMUs, and all male units AMUs) using scan sampling method. The data were analyzed using descriptive statistics. The combined data for OMUs and AMUs showed that feeding was the

Dominant activity (35.70%), followed by moving (26.83 %), and resting (15.93%), while drinking (1.95%) and mating (0.48%) were the least frequently observed activities. OMUs had a mean group size of 11.25 dominated by adult females (mean=4.5) while the mean group size for AMUs was 6.6. Adult females of OMUs spent more time feeding (21.28%) than the leader male (17.35%) while the leader male spent the highest time resting (32.14%) compared to other age and sex categories. OMUs showed more grooming (61.3%), mating (71.88%) and resting (61%) during the morning while feeding (64.5%) and drinking (48.72%) were more frequent in the afternoon. Similar to OMUs, feeding (43.33%) and moving (32.19%) were more frequent in the dry season while resting (22.58%) and grooming (15.13%) were more frequent in the wet season. AMUs exhibited more resting (65.85%) and grooming (60.65%) in the morning while feeding (61.32%) and drinking (52.83%) were more frequent in the afternoon. A total of 12 species of plants were consumed by the geladas and grass Blades constituted the highest proportion (79%).

Key words: Activity time budget, Behavioural activity, Diet composition, Group size, Gelada baboon, Guassa Community Conservation Area, One male unit, All male unit

1. INTRODUCTION

1.1. Back ground of the study

Ethiopia is one of the world biodiversity rich countries signified by the large number of species including many endemic taxa. It has diverse ecosystem ranging from alpine moor land to low land and savannas and arid lands and extensive wet lands (Yalden, 1983).The unique topography and wide range climate have made Ethiopia a home for diverse biological resources with more than 300 species of mammals (Afework Bekele and Yalden, 2013) and a variety of other fauna and flora. Among the mammals of Ethiopia, around 30% are species and subspecies of primates (Groves, 2005 and Kingdon, 1997).

Different species and subspecies of primates are found in Ethiopia. These are Bush baby or Senegal lesser galago *(Galago senegalensis)* and Somali lesser galago (*Galago gallarum)* (Butynski and deJong, 2004*),* Hamadryas baboon *(Papio hamadryas hamadryas),* Olive baboon *(Papio h. anubis),* black and white Columbus monkey *(Columbus guereza),* gelada baboon *(Theropithecus gelada),* grivet monkey *(Cercopithecus aethiops aethiops),* Black faced vervet monkey *(Cercopithecus aethiops pygerythrus),* Bale monkey *(Cercopithecus aethiops djamdjamensis)* ,Patas monkey *(Erythrocebus patas), Sykes monkey (Cercopithecus albogularis*) (Kingdon,1997 and Groves, 2005) and Blue Monkey *(Cercopithecu smitis boutourlinii)* (Fairgrieve and Muhumuza, 2003). Out of these, Blue monkey (*Cercopithecus mitis boutourlinii)* ,Bale monkey (*Cercopithecus aethiops djamdjamensis)* and Gelada baboon(*Theropiticus gelada*) are endemic to Ethiopia (Gippoliti, 2010). However, the gelada taxonomy remains little investigated (Gippoliti, 2010).

Gelada baboon is currently divided into two subspecies; Northern gelada (*Theropithecus gelada gelada*) and Eastern gelada or southern gelada (*Theropithecus gelada obscures*) (Mori and Belay, 1990). *Theropithecus gelada senex* is considered as another subspecies that occurs south of the Rift Valley in Arsi region, close to the Bale Mountain National Park of Ethiopia (Gippoliti, 2010).
The most distinguishing characteristic of gelada baboons is the presence of hairless patch of pink or red skin on their chest. Geladas are large, stocky primates with dark brown face and lighter, pale eyelids. The tail is shorter than the body and head and has a tuft at the end (Ankel-Simons 2007).

Geladas are graminivorous and show a high level of specialization in their diet than all other terrestrial primate species (Mau et al., 2009). They are primarily grazers, the major diet being grass blades (Dunbar and Dunbar, 1974, Dunbar, 1977). They chew grasses almost as efficient as zebras and are therefore nick- named "primate horses" (Dunbar, 1992). In addition to grass, they seasonally feed on seeds and in lesser amounts on herbs, fruits and rarely on insects (Iwamoto, 1993). They travel short distance for foraging every day in order to conserves energy. While other primates spend much of their time by travelling long distance for foraging each day to get high quality food (Fashing et al., 2007).

Gelada had to adapt itself to living at high altitudes in the Ethiopian highlands (Dunbar and Dunbar, 1975; Dunbar, 1998, and McCann, 2008). However, geladas' habitat has been seriously affected by natural and anthropogenic activities. Conversions of grassland and associated habitat types into other land-use types have affected foraging ecology of wild herbivores and geladas. This gradually led to a decline for a wide range of wildlife species (Houghton, 1994).

Knowledge about the behavior of animals is important for protection and conservation of the species and their habitats because behavior affects species persistence and existence in different ways. Sutherland (1998) suggested that the studies about the behaviour of animals provide key contributions to address conservation problems. Therefore, a better, understanding about the behavior of wild animals (habitat selection, foraging, movement, mating, and social system) can make a significant contribution for conservation of endemic species and keystone species. As a result, a comprehensive study about the behavioral record of gelada baboon is needed to help in formulating a strategy for conservation of the gelada ecosystem.

In Guassa Community Conservation Area (GCCA), only little emphasis was given for parts of an ecosystem without considering the behavioral records of wild animals in general and gelada in particular. Therefore, the purpose of the present study was to investigate the behavioral activity of Gelada baboons at GCCA through direct observation.

1.2. Objectives

1.2.1. General objective

- The goal of this study was to provide data on behavioral activity, group size and diet composition of gelada baboon in GCCA.

1.2.2. Specific objectives

- Identify the most and least common behavioural activity.
- Determine variations in activity pattern between age and sex groups.
- Assess behavioural variations between AMUs and OMUS of gelada populations.
- Identify the group size of AMUs and OMUs
- Assess the diet composition of AMUs and OMUs of gelada baboon

2. LITERATURE REVIEW

2.1. General characteristics of gelada baboon

The word "Baboon" came from French "babouin" which means a "gaping face" and "gelada" comes from an Arabic word meaning "mane" (Anonymous).

The Ethiopian endemic species, *Theropithecus gelada*, commonly called the gelada baboon; was first discovered by the German naturalist Ruppel in 1835 in few areas of the Northern Ethiopian Highlands (Crook, 1966**).** Formerly, it was believed that the genus *Theropithecus* included several extinct species which were widespread and successfully found over much of Africa and India. But, at present, the gelada baboon (*T. gelada*) is the only surviving member of the genus *Theropithecus* that occurred widely through the savanna grasslands of sub-Saharan Africa (Dunbar, 1986).

Today, geladas are found in few areas of the Northern Ethiopian Highlands (Fig.1). It occurs predominantly in the Semen Mountains where it is observed in large numbers .But it also occurs in small numbers in Menz (Guassa), Debresina, Debrelibanos, and Wollo. An additional isolated population was discovered in the Arsi region, south of the Rift Valley and east of the Bale Mountains (Mori and Belay, 1990).

Gelada baboons do not have close relations with the typical baboons of the genus *Papio*, but they have certain similarities in terms of ecological adaptation in morphology and behavior as part of convergent evolution (Crook, 1966).

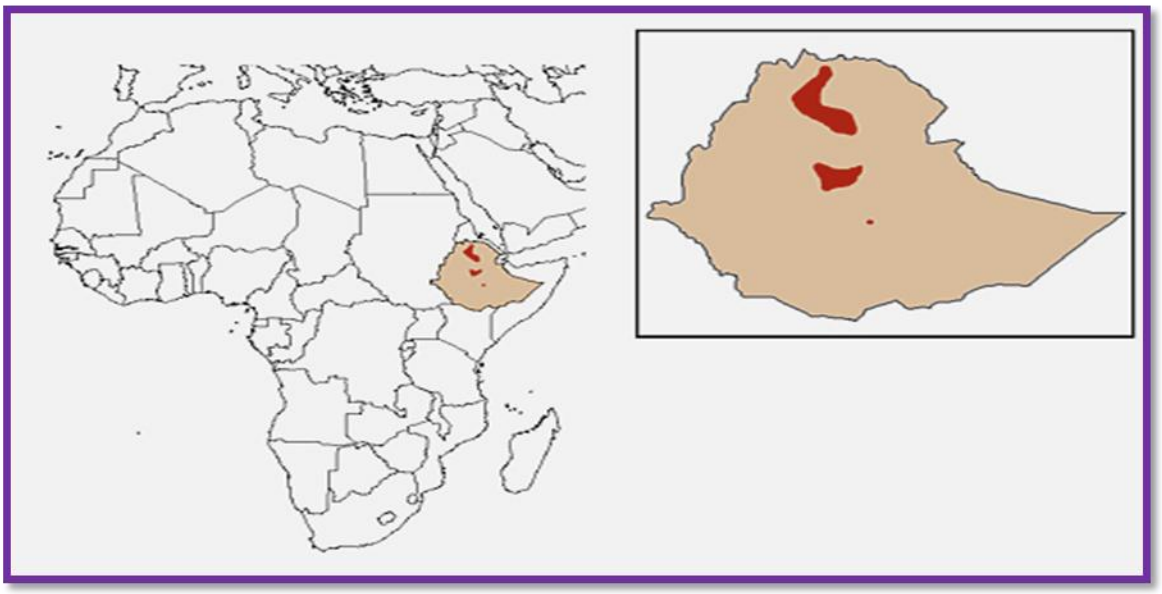


Figure 1: Range map for *Theropithecus gelada* (Source: Eshetu Moges, 2015)

2.2. Taxonomy

Gelada baboon is a species of old world monkeys whose taxonomy is a subject of much debate (Yalden and Largen, 1992). According to Goodman (1998), the gelada baboon should be grouped with its *Papionini* kin; but according to McKenna and Bell (1997), this species is even farther distant from *Papio*. While *Theropithecus gelada* is the only living species of its genus, separate, larger species are known from the fossil record; *Theropithecus brumpti* and *Theropithecus darti* (Hughes *et al*.,2008) as well as *Theropithecus swaldi*, formerly classified under the genus *Simopithecus* (Maier, 1972).

Goodman (1998) hierarchically classified the gelada baboon as follows: Kingdom: Animalia, Phylum: Chordata, Class: Mammalia, Order: Primates, Family: *Cercopithecidae,* Subfamily: *Cercopithecinae*, Tribe: *Papionini*, Genus: *Theropithecus* and Species: *gelada.*

2.3. Morphology

Gelada baboons are large C*ercopithecine* primates. They have dark brown to buff coarse pelage, dark brown faces, and lighter pale eyelids. The adult male has a heavy cap of hair (large mantle or mane) on its back and dark grayish brown ventrally. Female lacks a cap (mantle or mane) and the fur is yellow brown dorsally and dark grayish brown ventrally. The eyelids are very pale, contrasting with the dark facial skin. Males have much larger canine teeth than females (Hughes *et al*., 2008). Between sub-species, *T.g. gelada* has a pale brown to dark brown pelage while *T. gelada obscurrus* is darker, ranging from dark brown to almost black (Yalden, et al., 1977).

One of the gelada's most striking features is the hourglass-shaped patch of bare skin on the chest. In males, the colour of the patch is a signal for male quality: leader males have redder chests than follower or bachelor males, and leader males with larger units have redder chests than those with smaller units (Bergman & Boehner, 2009). This colouration can change dramatically in a few days, becoming paler when a leader male is replaced or brighter when a male becomes a leader (Dunbar & Dunbar, 1975).

In females, the chest patch changes over the course of the reproductive cycle. During estrus, a "necklace" of raised beads or vesicles appears around the edge of the bare skin (Fig2. B) (Dunbar and Dunbar, 1974).

Figure2.View of anestrous (A) and Estrous (B) female gelada at GCCA (Sarah Erskine, 2016)

On the average, males are larger than females and marked sexual dimorphism is characteristic feature of the species, with females averaging around two– thirds the size of males (Krentz, 1993; Jolly, 2007) (Fig.3). The average body mass for an adult male Gelada baboon is around 20 kg and for the female, it is between 13 and 16 kg. The male measures between 69 and 74cm, and a tail between 45 and 50 cm, the female is between 50 and 65 cm and a tail between30 and 40 cm long (Jolly ,2007).

Gelada baboon has highly opposable index fingers and thumbs. In addition, its fingers are short and substantially built allowing them to be used efficiently for digging (Dunbar, 1976).

The mating system of a species has a greater impact on the morphology and physiology of both sexes. Monogamous and polyandrous (having more than one male mate) species show virtually no dimorphism. However, in species living in one male mating system, there is a marked sexual dimorphism. This is because; body and canine size dimorphism are closely associated with the amount of direct competition among males for mating success to females. On the other hand,

species living in multi male groups show intermediate level of dimorphism (Harcourt *et al*., 1981).

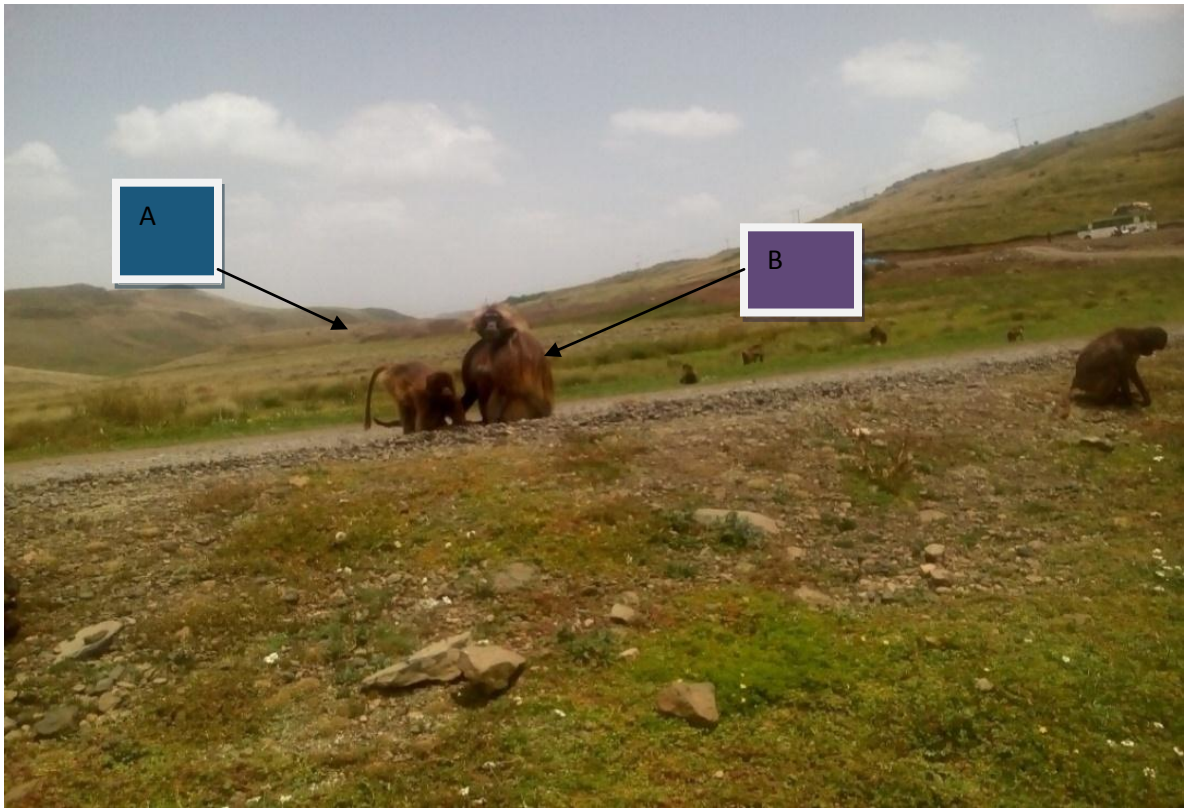


Figure 3: View of the morphology of female (A) and male (B) geladas (Photo by: Mandefro mamo)

2.4. Habitat and feeding behavior

The gelada baboons are terrestrial primates that live along the edges and steep slopes of open cliffs. In the morning, the gelada baboons escape from their cliffs and travel to the top of the mountain where immediately begin social activity and feeding (see Fig.4).

Figure 4: View of the habitat of Gelada baboons at the study area (photo by: Mandefro mamo)

Geladas mainly feed upon herbs, grasses (most of the time) and roots but they also rarely eat insects. They never hunt or kill small birds and mammals. As a result, they are forced to spend most of their time in foraging and browsing to obtain sufficient nutrients (Last, 1982). They forage by sitting down and shuffle along the ground and pickup grass blades using the thumb and index finger (See Fig.5).

The feeding posture and associated locomotion of gelada baboon varies with seasons. During rainy season, geladas feed by sitting and foraging with both hands using their thumbs and first digit to pick suitable green grass blades. During the dry season, when preferred foods are underground, gelada dig using both hands as shovel (Crook and Aldrich Blake, 1968).

Figure 5: View of the feeding activity of gelada baboon at GCCA (Photo by: Mandefro mamo)

2.5. Social organization and structure

Food distribution and predation are among the most important ecological factors that determine the social organization of the gelada. They have also an impact on social structure and mating system (Van Schaik, 1996, Lendenfors *et al*., 2004). The gelada baboon form large groups or aggregations on a permanent or regular basis. These large groupings can be determined by various ecological needs such as predation avoidance, optimal habitat use and foraging, male mate defense and infanticide avoidance. Though group living has its own disadvantages such as increased competition with other individuals for the same resources of food and mates, it maximizes their survival and that of their offspring (Dunbar, 1984).

The social system of gelada consists of the social organization, the social structure, and the mating system (Kappeler et al., 2002).

2.5.1. Social organization

The social organization of gelada consists of a hierarchy of social groupings. The smallest and basic social level in gelada baboon is the reproductive unit or harem (Kawai, 1983). The reproductive units of the gelada baboon are made up of one fully adult male, females (ranging from1-10), and their offspring. In the reproductive units, there is always one dominant female, usually the youngest sexually mature female (Dunbar, 1983) (Fig.6). Other females do not compete with her for seeking the male. About 25 % of one male unit (OMU) also includes one or more follower males (Nowak et al., 1999). Followers may be former leader males who were defeated by a rival and lost their dominant position, or else they may be young adults who are waiting for their chance to take over the leader male role. Follower males are tolerated by the leader male, and they may help the leader male to defend the unit against takeovers by other males outside the unit. Leader males have been found to have longer tenure as the leader when a follower male is present, and some follower males' father offspring within the unit (Snyder-Mackler et al, 2012).

Figure6. A reproductive unit of gelada baboons at GCCA (Photo by: Mandefro mamo)

The gelada males that are outside a reproductive unit socially organized into the bachelor unit or all male unit (AMU) which consist of 2-15 males (Fig.7).

Figure7: A bachelor unit of gelada baboons at GCCA (Photo by: Mandefro mamo)

Bands are the other form of social organization in geladas that are formed when the home range of the reproductive units overlap. A single band typically consists of 2-27 reproductive units and several all male or bachelor groups. Generally, 100 animals of all age and both sexes can be included in a single band (Dunbar, 1993). According to Dunbar (1993), the largest bands recorded contained 325-350 animals. Geladas forage together but do not groom with the members of other bands. The third social level in gelada social organization is herd (2-60 reproductive units). Herd can be formed when the home range of bands overlap and geladas forage together. This usually happens when sufficient amount of food source is present. Over 400 individuals of gelada baboons can be grouped together in a given herd (Last, 1982). Within herds, each one-male unit remains spatially distinct from all others. However, there is also a

tendency for certain units to occur in spatial association with others. Unit leaders maintain spatial separation between units by coming together with their females whenever the females approach too close to another unit or all-male group (Kawai and Iwamoto, 1979). The highest level in gelada social system is the community that includes the entire population that may interact over several years (Snyder-Mackler et al., 2012). Individual units can be readily identified because all members of a unit are always together, but identification of the higher levels of social organization is not obvious and requires long-term observation (Boehner and Bergman, 2009). Across all these levels of society, female members of units and bands that spent more time together were found to be more closely related in a genetic analysis (Archie et al., 2014).

The composition of such various grouping system in gelada baboon changes gradually as a result of birth and death. Permanent migration of reproductive units between bands appears to be very rare. However, emigration by reproductive units to new ranging areas is more common (Dunbar, 1993).

2.5.2. Social structure

The social structure of gelada refers social interactions and relationships which includes, inter and intra band relationships, inter-individual relationships, female-female relationships, female-male relationships and male-male relationships. In *Theropithecus gelada*, large mixed bands are formed without recognition among individuals (Oshawa, 1979). But almost all social interactions of adults are between individuals of the same OMU or all male units AMU (Dunbar, 1979). In the reproductive units, a strong social bond is shared by all of the females. The bond between the females is established because of high relatedness among them. The members of the same family units move together, forage together, sleep together and groom each other. Grooming entails simply picking parasites and cleaning their body with each other. This is not only a friendly and peaceful occupation, but serves also to establish bonds between various members of a 'harem'. It also develops strong relationship in the hierarchy, between male, female, older and young members (Last, 1982).

Aggression is one of the social interactions in gelada baboon. Little aggression takes place within a reproductive unit while the majority of aggression is directed outward towards non-unit individuals. The female geladas mostly initiate the majority of aggression and if the conflict becomes more severe both males and females of the opposing sides get involved (Dunbar and Dunbar, 1975). Within the reproductive unit of gelada baboon, there is a hierarchy of females,

with lower-ranking females attaining less reproductive success and having fewer offspring than higher-ranking individuals (Dunbar 1980; Dunbar, 1993). Closely related females have similar social status within the hierarchy (Dunbar, 1980).

2.6. Mating and reproduction

Mating and reproduction occur within the reproductive units of the gelada baboon.

Reproduction occurs throughout the year and the species does not display a distinct reproductive season, though it has been noted that the birth rate is higher during the rainy season (Jolly, 2007). Gelada baboon has a polygamous mating system. The reproductive units of gelada may contain more than one male, but only one male is reproductively active to the exclusion of extra-male groups (Ohsawa, 1979). Therefore, only the unit leader male copulates with the unit females (Mori, 1979). Before copulation, the female solicits the male. The female gelada shows a distinctive solicitation posture which can easily be recognized by the unit leader male. The female solicitation posture usually involves pointing and raising her abdomen towards a male and moving her tail to one side to solicit the group leader male. The leader male approaches the female and copulate with her. Copulation usually lasts only around ten seconds and accompanied by vocalization. Most copulation takes place during the morning before mid-day and when in estrus, a female usually copulates 2-5 times per day. Males do not sexually interact with females of units other than their own (Dunbar and Dunbar, 1975).

Gestation length in gelada baboons is estimated about 5 to 6 months. Females generally give birth to one infant at a time and females with infants are anestrous (Kawai, and Iwamoto, 1979). The male gelada reaches sexual maturity at the age of 6 years where as the females at about 4 or 5 years of age (Dunbar & Dunbar 1975; Dunbar 1984). Males usually do not father offspring before 8-10 years of age due to social factors (Jolly, 2007). Males begin to leave the unit at about 2 years age, but all depart from the natal harem by the age of 5. However, the females remain in their units for their entire life. Changes in the visual appearance of the sexual skins of female geladas are associated with different stages of the reproductive cycle (Dunbar and Dunbar, 1974). Changes in the appearance of the skin when the female is in estrus involve, change in tissue around the vulva (external parts of the female genital organ) from flat and pale to inflated and pinkish. Then it becomes deflated and becomes bright pink when they are pregnant. If conception is unsuccessful, the female's sex skins return to its original color and shape. Once the females reach sexual maturity, they may try to mate with the dominant male, but usually are unsuccessful. This is probably an adaptive behavior to prevent inbreeding. The usual pattern for

males is to emigrate from the natal group at puberty, spend several years in an all male-group, and then attempt to monopolize a reproductive unit (Dunbar, 1993).
The mating strategy for the female gelada is male choice. But for the male, it is male-male competition for the most possible copulation. The dominant males continuously try to protect females from other males.

In gelada baboons, there are different options for the bachelor male to acquire breeding females.

1. Challenging and defeating the current leader male: A male from the bachelor unit fight with the leader male and the bachelor male defeating the former leader male. Therefore, the new male becomes the leader of the group and the former leader male existed as subordinate.

2. Submissively attaching themselves to OMU (followers) and pairing with young females and take some females with him to create a new reproductive unit. Thus, male from the bachelor unit enters into the reproductive unit and paired with the young females and gradually departed to form an independent reproductive unit (Kummer, 1968).

2.7. Parental care

Gelada baboon birth mostly takes place at night, but have been observed in the early morning. At birth, the infant's eyes are closed, the face is red, and the body is covered with black hair until around three months old (Dunbar and Dunbar, 1974).
The average birth weight of the infant of gelada baboon is about 464.0 g (Leutenegger, 1973).
In gelada baboon parental care is primarily the responsibility of the female. Starting from birth, the infant is carried ventrally or predominantly carried on the mother's back (Fig.8A), sometimes with its tail entwined with hers (Fig.8 B) (Barrett et al., 1995).

At five months of age, the infants are more likely to be moving independently than being carried ventrally or on the mother's back (Barrett et al, 1995). The infant first starts trying to move away from its mother at two weeks old. When the young males reach puberty, they aggregate into unstable groups that may move independently of reproductive units. Starting around six months old, subordinate males may help the female to provide care for a specific infant (Mori, 1979).

Figure 8: View of the mother geladas carrying their infants on the back (A) and on the *tail (B) (Photo: Mandefro mamo)*

2.8. Ranging behaviour

As food availability is much greater in the highlands than the lowlands, geladas move for only a short distance a day compared to the hamadryads baboon (*Pappio hamadryas*) (Dunbar and Dunbar, 1975). The daily moving distance of gelada is 1-2km (Iwamoto and Dunbar, 1983). The range varies daily and seasonally but is closely related to group size. If food is limited, geladas with large group size move longer distances (Kawai and Iwamoto, 1979). Similar to daily range, home range, which varies between 0.78-3.44 $km^{2,}$ is related to group size, with large groups possessing larger home range (Iwamoto and Dunbar, 1983).

2.9. Conservation status and conservation threats

Geladas live at high altitude of Ethiopia, with an elevation ranging from 1500-4500m (Iwamoto, 1993). Most of the highlands and some of the lowlands of the country have been altered because of natural and anthropogenic activities. *Theropithecus gelada* most probably

experienced a great predation pressure in the past (Iwamoto, 1993). At present, the actual and potential predators that threatened the geladas are hyenas, foxes, leopards and dogs (Dunbar and Dunbar, 1975).

Geladas are protected in the Semen Mountains National Park, a UNESCO World Heritage site, and hunting of the species inside the park is forbidden (Oates, 1996). This park was established for the conservation of the extremely rare Walia Ibex (*Capra walie*) instead of the geladas (Dunbar, 1993). The total wild population of gelada is estimated at slightly less than 250,000 individuals (Dunbar, 1998).

Human encroachment into the gelada preferred habitats for different activities (agriculture, fire wood collection, and cutting grass) greatly affect the geladas. This is because as the gelada preferred habitat is destroyed, geladas will most likely to have to move to more marginal areas, and this leads to a reduction in the population density of the species (Dunbar, 1977).

Additionally, due to their specialized diet, geladas are severely affected by drought and soil erosion which are the results of unwise use of the gelada habitat. Geladas are also potentially threatened by global climate change predominantly due to their altitudinal restricted habitat. If temperature rises, the altitude of mountain grasslands would increase and eventually the gelada habitat would no longer continue to exist.

Clearing of vegetation in certain areas of gelada's habitat and replacing by quick growing non-native species such as *Eucalyptus globules* and *Cupressus lustanica* by the local farmers indirectly threatened the species. These invasive species do not retain soil and inhibit the growth of grasses which are the most preferred diet of geladas (Dunbar, 1977).

In the past and even recently, local people killed male geladas for their mane to be used for ceremonial head-dresses. This discriminate killing which only reduces the male from the population alters the species reproductive and social dynamics (Dunbar, 1993).

Though geladas' preferred diet is grass, in time of drought, they will raid crops especially during harvesting time (Dunbar, 1977). This leads to a conflict between the geladas and local farmers.

At present, road construction, replacement of the Guassa grass by *Helichrysum spp., Cupressus lustanica* and *Eucalyptus* forest plantation by local farmer, agriculture expansion and house building (near gelada habitat) largely affect the habitat and feeding ecology of gelada baboon at guassa community conservation area (see Table 1).

Table1: Sources of threat to the fauna, flora and other natural resources of the Guassa Community Conservation area (GCCA).

Priority Ecosystem Component	Threat	Ranking
Hydrological system (Water catchment)	Overgrazing, particularly in wetlands Unsustainable fuel wood and grass harvesting Agricultural expansion	High Medium Low
Festuca grassland	Unsustainable grass cutting Overgrazing Global warming	High Medium Low
Ethiopian wolf	Disease Small population and insularity e.g. genetic loss, demographic and Direct persecution/human conflict Hybridization Global warming	High High Medium Low
Gelada baboon	Overgrazing Grass cutting Direct persecutions/ human conflict Global warming Agriculture expansion	High Medium Medium Low Low

(Source: The community-managed plan Guassa Area Menz, 2007-2012)

3. DESCRIPTION OF THE STUDY AREA

3.1. Geographical location

The study was conducted the Guassa Community Conservation Area (GCCA) also known as Guassa Park, of Menz-Gera Midir Woreda, located in the central highlands of Ethiopia: North Shoa Zone of Amhara National Regional State (Fig. 9). GCCA is 265 km from Addis Ababa. The geographic coordinates are10˚15'-10˚27'N and 39˚ 45'–39˚ 49′E. The total area of GCCA is 78 km^2. Its altitude ranges from 3200 m to 3700 m a.s.l. (Zelalem Tefera, 2001).

Guassa is part of the Menz Geramidir Woreda and it is surrounded by five Kebel administrations : Alphamidir (west), Yedi (south), Dargegn (north), Chare (west) ,Wojed (north) and by two kebele (Dija and Mehalwonz) administrations of Ephrata ena gidm woreda (east).

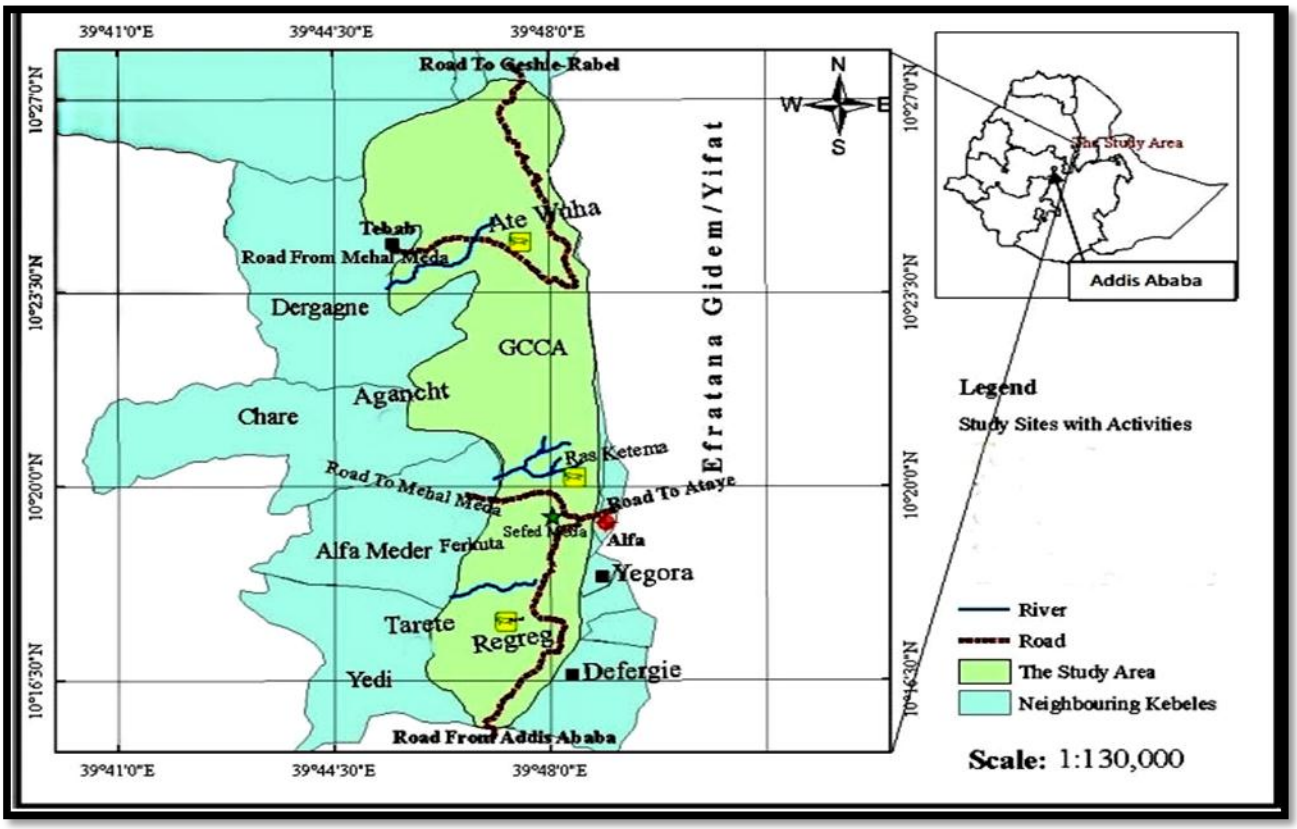


Figure 9: Map of the study area (GCCA) with adjacent Kebeles (Source: Engidasew Andarge, 2010)

3.2. Climate

The climate of the central high land is characterized by a tropical type. The climate of Guassa area varies with altitudinal gradient and seasonal changes. At higher altitudes wet season is characterized by combination of high rainfall, hail storms and occasional snow.

During the dry season frosts are common. The Equatorial Western lees and the Indian Ocean air streams are the sources of rain in Guassa during different times of the year. Even though showers of light rain can occur in any month of the year, the distribution of rainfall in Guassa area is characterized by a bimodal pattern. A short rainy season occurs during February-April and the main rainy season mostly occurs between June and September. The annual rainfall at Guassa ranges from 1,200 to 1,600 mm (Zelalem Tefera, 2001).

There are sharp temperature fluctuations between night and day time due to the altitudinal differences and the size of the mountain block. The temperature is characterized by mild days and cold nights. In the driest months (December-February), day time temperatures can rise up to 25^0C, while night time temperatures can fall down to -7^0C (a diurnal fluctuation 32^0C) (Fig. 10).

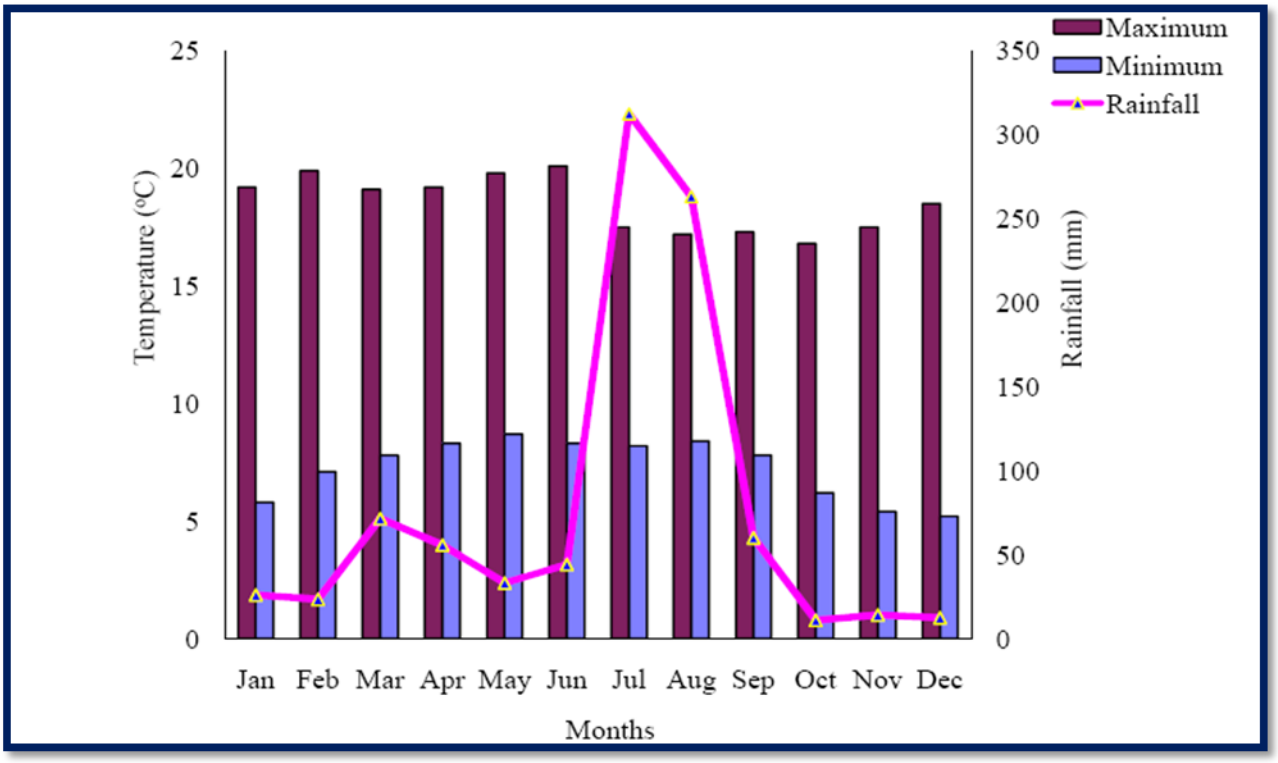


Figure10. Monthly mean minimum and maximum temperature and rainfall in Guassa Community Conservation Area (2000-2014, (Source: Eshetu Moges, 2015)

3.3. Hydrology and topography

The Guassa community Conservation area is surrounded by a steep escarpment of the Rift Valley in the east and low-lying agricultural areas of Menz in the west. The escarpment of the eastern side of the Guassa area forms a continuous north-south wall, with cliffs.

This cliff provided the area with spectacular scenic beauty and stunning views across the Yifat and Great Rift Valley up to the Awash River in the Afar (Zelealem Tefera, 2001; Zelealem Tefera and Leader-Williams, 2005). The Guassa area is a water catchment for many streams and rivers draining into the low-lying areas of North Shoa. It provides water to two major river systems, namely the Abay to the west and the Awash to the east.

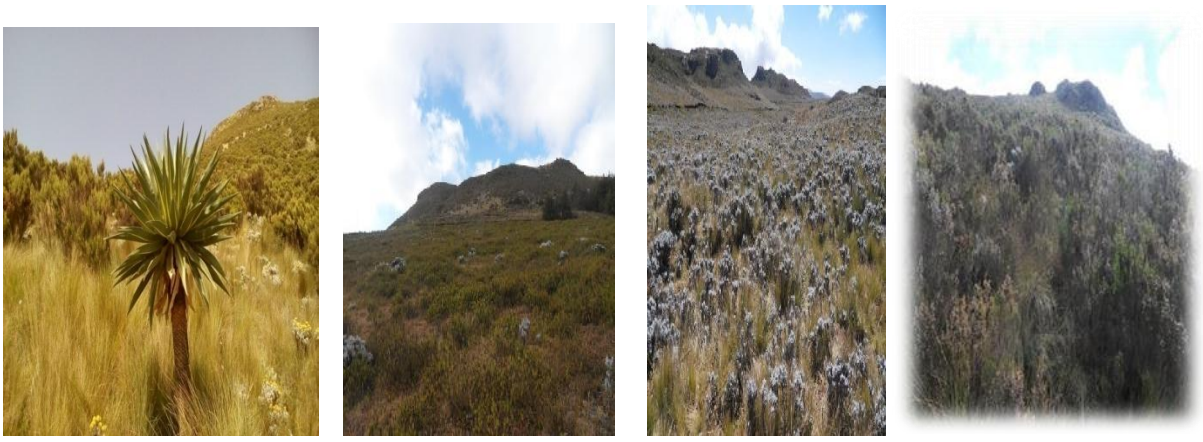
Twenty six small and medium sized rivers start from the Guassa area flowing to the west and east sides of the mountain block (Zelealem Tefera, 2001). The Guassa area comprises hills and valleys interspersed with swamps and open areas of mountain and alpine grassland. These provide water holding capacity and also limit runoff in the rainy season, thus providing flow all year round.

3.4. Flora and habitat types

The vegetation of GCCA is characterized by a high altitude afro – alpine vegetation in which different vegetation communities exist. The afro alpine vegetations of the Guassa area are classified in to the following habitat types (Zelalem Tefera, 2001).

1. *Fastuca* grassland (Menz Guassa grass land) occurs where the drainage is good and the soil is deep. It grows on steep to moderately steep slope up to an altitude of 3500m asl (Fig.11, A).
2. *Euryops-Festuca* grassland usually interspersed with scattered mounds that can reach a height of 1.5m and diameter of 5-10m these mounds consist of highly organic and deep soil that is made by the activity of the rodent community.
3. *Euryops-alchemilla* shrub land occurs on flat and gentle slopes and well drained areas and is restricted to areas above 3200m asl (Fig. 11, B).
4. *Helichrysum-Festuca* grassland this vegetation community is found on high ground and hill tops, where the soil is poor (Fig.11, C).
5. Erica moorland community found on higher ground areas with shallow and well drained soil (Fig.11, D).
6. Swamp grass lands an area that is permanently or temporally inundated in the season. The Afro mountain vegetation varies with altitude and is a key attraction of the area. The most predominant flora in the study area is *Festuca* grass or Guassa grass. But, other vegetation that can be present in the area includes *Euryops-alchemila* shrub land and *Erica moor* land.

Common plants include *Carex fisheri*, *Lobelia rhynchopetalum*, *Hydrocotyl mannie* and *Kniphofia foliosa* (Hailu Beyene, 2010).



(A) *(B)* *(C)* *(D)*

Figure 11: Vegetation types at GCCA (A, Festuca grass land with giant Lobelia, B, Euryops Alchemilla, C, Helichrysum-Festuca, D, Erica moorland) (Photo: Mandefro Mamo)

3.5. Fauna

The Guassa community conservation area is characterized by the presence of a great diversity of wildlife. It harbors 23% of the endemic mammals of Ethiopia, including the Ethiopian Wolf (*Canis simensis)*, Gelada baboon (*Theropithecus gelada*) and the Abyssinian hare (*Lepus starcki*). The Ethiopian wolf is legally protected, and with a total world population of 500 individuals. It is the most endangered animal in the world. The other large endemic mammal is gelada baboon. Other mammals found in the study area are the grey duiker, spotted hyena, leopard, common jackals and several cats (Table 2).

Table2: Endemic mammals in GCCA (

No.	Common name	Scientific name
1	Ethiopian wolf	*Canis simenisis*
2	Gelada baboon	*Threropithecus gelada*
3	Abyssinian hare	L*epus starcki*
4	Abyssinian meadow rat	*Stenocephalemus grisecauda*
5	Un striped grass rat	*Arvicanithis abyssinicus*
6	Shrew	*Crocidura thalia*

(Source: P. Fashning, 2013)

The study area also harbors over 114 species of birds. Among them, 14 species are endemic to Ethiopia, including the restricted-range Ankober seedeater (*Crduelis ankoberensis*) and Spot breasted plover (*Vanellus melanocephalus*) (Zelealem Tefera and Leader William, 2005). It also serves as a wintering ground for 38 species of Palearctic and Intra-African migrant birds (Zelealem Tefera, 2001). A striking feature of the bird life in the Guassa area is the abundance of birds of prey that feast along with the Ethiopian wolves on several species of rodents in the area, which form most of the diet of the endangered wolf (Yalden and Largen, 1992). Some of the endemic bird species found in GCCA are listed in Table 3.

Table3: Endemic bird species at GCCA

No	**Common name**	**Scientific name**
1	Ankober serin	*Crduelis ankoberensis*
2	Abyssinian cat bird	*Parophasma galinien*
3	Abyssinian long claw	*Macronyx flavicoils*
4	Blue-headed siskin	C*yanochen cyanoptera*
5	Black- winged goose	*Serinus nigriceps*
6	Black-winged lovebird	A*agapornis taranta*
7	Rougets rail	R*rougetius rougetil*
8	Spot- breasted plover	V*vannellus melanocephalu*
9	Thick-billed raven	*Corvus crassirostris*
10	Wattle ibis	*Bostrychia carunculata*
11	White- collared pigeon	*Columba albitorquea*
12	Whit- winged Cliff chat	*Myrmecocichla semirufa*

(Source: P. Fashning, 2013)

4. METHODS

4.1. Sampling population

Behavioral data records were collected by studying One Male Unit (OMU) and All Male Unit (AMU) of gelada baboons that belonged to the same band. The study subjects were members of a population of wild geladas living in GCCA in Amhara Region North Shoa Zone.

4.2. The study period

The data were collected in 24 days (12 days for OMU and 12 days for AMU) between August 2017 - November 2017 for eight days during August and September and for four days during October and November. August and September were taken as the rainy season while October and November as the dry season. The data collection started at 7:00 hrs in the morning and ended at 18:00 hrs in the afternoon.

4.3. Data collection

Instantaneous scan sampling method was used to collect behavioral data on OMUs and AMUs (Altmann, 1974). One OMU and one AMU were identified from the same band. The identified units of the band were taken as the focal units for each day of observation. New units were selected for each subsequent scanning. Unique physical features such as tumor, abscess, short tail, body size, and cape were used to identify individuals in OMUs and AMUs.

The behavior of gelada baboon was recorded by approaching the OMUs and AMUs at a distance of five to ten meters (Fig. 12). The study animals were divided into different demographic categories. For one male unit (OMU) the individuals were categorized into five demographic classes: Juveniles, Sub-adult females, Adult females, Follower males and Leader males (Sarah Erskin, 2016). But, for the all male unit, the individuals were categorized as adult and sub-adult males. In OMU the Adult females were generally larger than sub-adult females. Leader males were large, healthy-looking, adult males. Follower males fell into two categories: young adults who were smaller than adult males, with less developed manes, and older followers, who had been leader males and then been overtaken by younger, stronger males (Sarah Erskine, 2016). During each follow, all identifiable daily activity of the study population was recorded on the separate behavioral data sheets.

The data collection in each day was categorized into three periods: Morning (07:00-11:00 hrs), Midday (12:00-14:00 hrs), and Afternoon (15:00-18:00 hrs). In each hour, behavioural activities

were recorded for 10 consecutive minutes followed by 10 minutes of pause. As such, there were three scanning periods per hour and 27 scanning per day.

(A) (B)

Figure12: Observing the bachelor unit (A) and the reproductive unit (B) of gelada baboons at GCCA

4.4. Categories of behavioural activities

The major activities of gelada baboons that were recorded during the study period were feeding, moving, grooming, aggression, mating, playing and drinking. Feeding was recorded when individuals were walking while chewing , slowly walking to pick food , shuffling from one food site to the next, grazing, foraging or digging and consuming the different food items. Moving was recorded when geladas were walking or running without chewing. Resting was recorded when the geladas were sitting, standing, lying down and relaxing. Grooming was recorded when the individuals were cleaning or remove parasites from the body. Aggression was recorded when individuals were chasing, biting, threatened and grabbing. Mating was recorded when individuals performed courtship display and mounting. Playing was recorded when individuals were fighting, chasing and grabbing peacefully without harming one another. Drinking was recorded when individuals use water. Suckling, defecating, and watching were recorded as others (*Eshetu Moges, 2015).*

4.5. Diet composition

During the study the major plant species and the parts consumed by gelada baboons were identified using local names. A list of the local and scientific names of plants was obtained from Guassa administrative office (Table 4).

Table 4. A list of the local and scientific name of some plant species in GCCA (Source: Guassa administrative Office).

No	Local name	Species name
1	Grass	*Festuca macrophyla*
2	Tosign	*Thymus schimperi*
3	Kega	*Rosa abyssinica*
4	Jibra	*Lobelia rhycchopetalum*
5	Abelibila	*Kniphofia foliosa*
6	Getim	*Haplocarpha schimperi*
7	Ameja	*Hypericum revolutum*
8	Asta	*Erica arborea*
9	Eja/ Gime	*Brocea antidysenterica*
10	Nachilo	*Senra incana*
11	Yewaliya eshoh/Garda	*Helichrysum spp*
12	Yeabesha tid	*Juniperus Procera*
13	Yeferenj tid	*Cupress lustanica*
14	Yeabesha koso	*Hagenia abyssinica*
15	Cherenfe	*Euryops pinifolius*
16	Embuacho	*Rumex nervesus*
17	Enjory	*Rubus apetalus*
18	Tult	*Rumex nepalensis*
19	Lut	*Malva verticillata*
20	Ketema	*Typha latifolia*
21	Yemidir Kosso	*Alchemilla abyssinica*
22	Sama	*Urtica simenisis*

4.6. Data analysis

The percentage of each activity time budget was calculated by dividing the proportion of behavioral records for each activity category by the total number of activity recorded each day. Then, it was summed up for each month to construct proportions of time budget. The activity time budget of the gelada baboons is calculated by using the following formula:

$$\text{\% of Activity time budget} = \frac{\text{number of records of a given activity}}{\text{Total number of all behavioral records}} \times 100$$

The data were analyzed using descriptive statistics and presented in the form of tables and figures.

One sample t-test at the 95% confidence interval was used to determine statistical significance in the variation of the overall activity time budget. SPSS statistical software ver. 17 was used for the analysis.

5. RESULTS

5.1. One male Units

Group size

Group size of OMUs ranged from 8 to 15. The mean group size was 11.25. The number of juveniles ranged between 2 and 5. Adult females comprised the highest number in the OMUs (mean=4.5) while juveniles were the next more frequent members (mean=3) (Table 5).

Table 5: The number and demographic composition of the OMUs.

Day	Number of studied animals (OMUs)					Total
	Juveniles	Sub-adult females	Adult females	Follower males	Leader males	
1	2	2	3	0	1	8
2	2	1	3	1	1	8
3	3	1	4	1	1	10
4	3	2	4	2	1	12
5	2	2	6	1	1	12
6	3	2	4	2	1	12
7	4	2	4	1	1	12
8	4	2	6	2	1	15
9	5	1	4	1	1	12
10	2	1	6	2	1	12
11	3	1	4	1	1	10
12	4	0	6	1	1	12
Total	**37**	**17**	**54**	**15**	**12**	**135**
Mean	**3.08**	**1.42**	**4.5**	**1.25**	**1**	**11.25**

Activity time budget of the OMU of gelada baboons

A total of 2780 individual behavioral observations on the various activities of OMU of gelada baboons were recorded throughout the study period. Feeding comprised about 36.69 % followed by moving (25.86%) and resting (15.12%). Aggression (1.69%) and mating (1.15%) were the least commonly observed activities. The variation in the percentage frequency of the different activity categories was statistically significant (p=0.029) (Fig. 13).

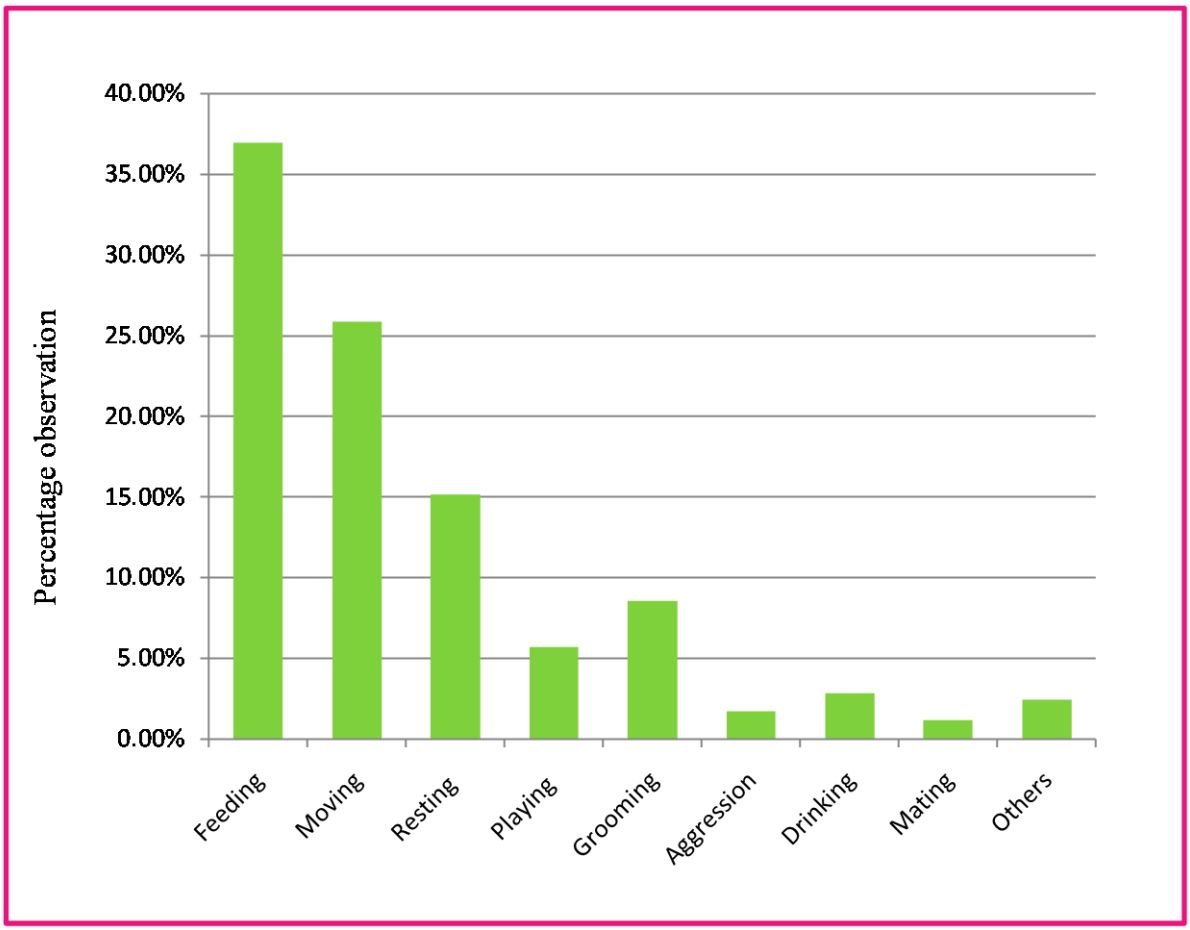


Figure 13.The overall activity time budget of the OMU of gelada baboons at GCCA

Seasonal variation in the activity time budget of OMU of gelada baboons

Gelada baboons spent more time on feeding (44.55%) during the dry season than the wet season (27.78%). Similarly moving was most frequent during the dry season (32%) than the wet season (18%). On the other hand resting (20.49%), playing (8.52%), and grooming (12.97%) were more common during the wet season than the dry season (Fig. 14).

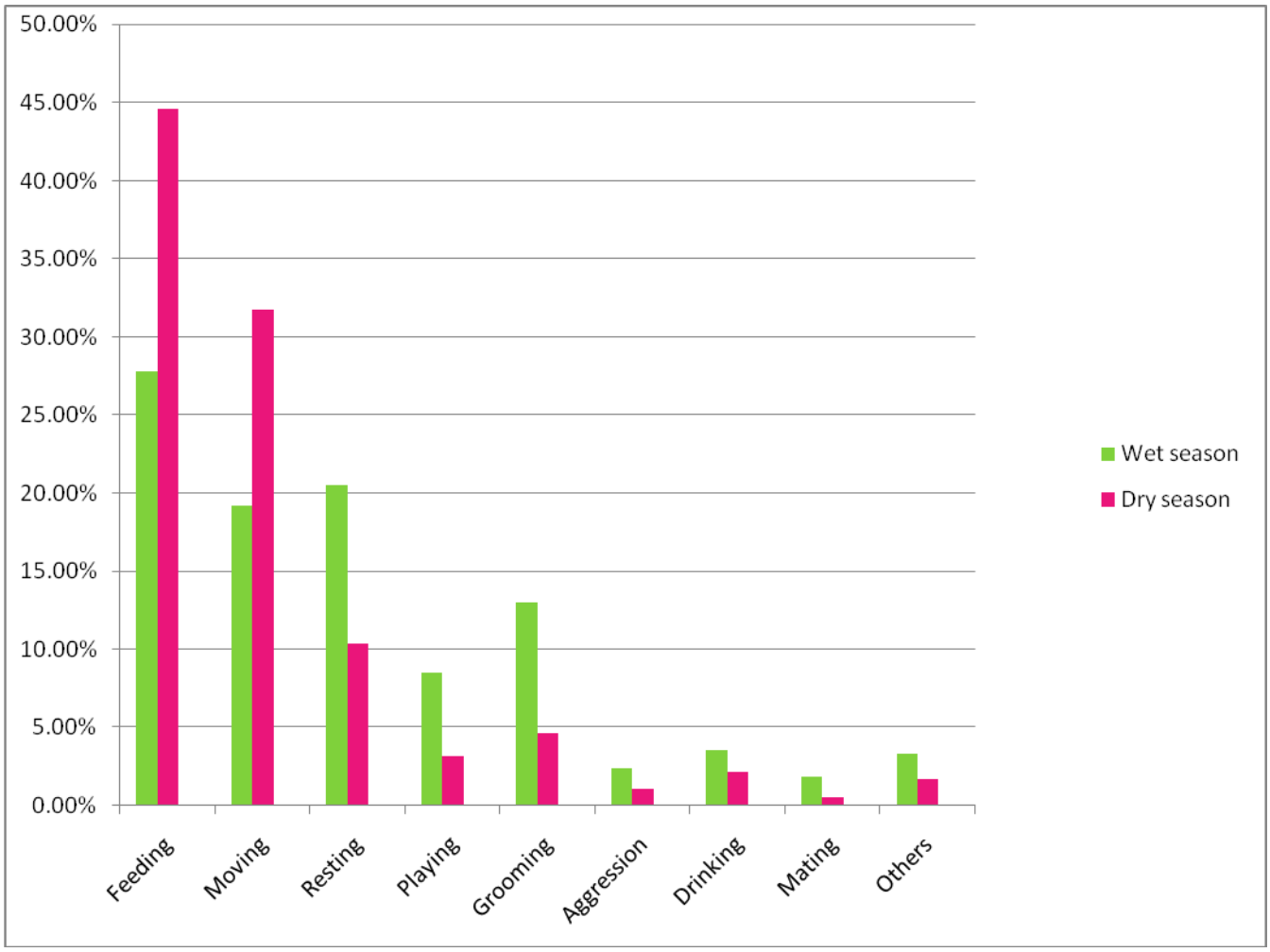
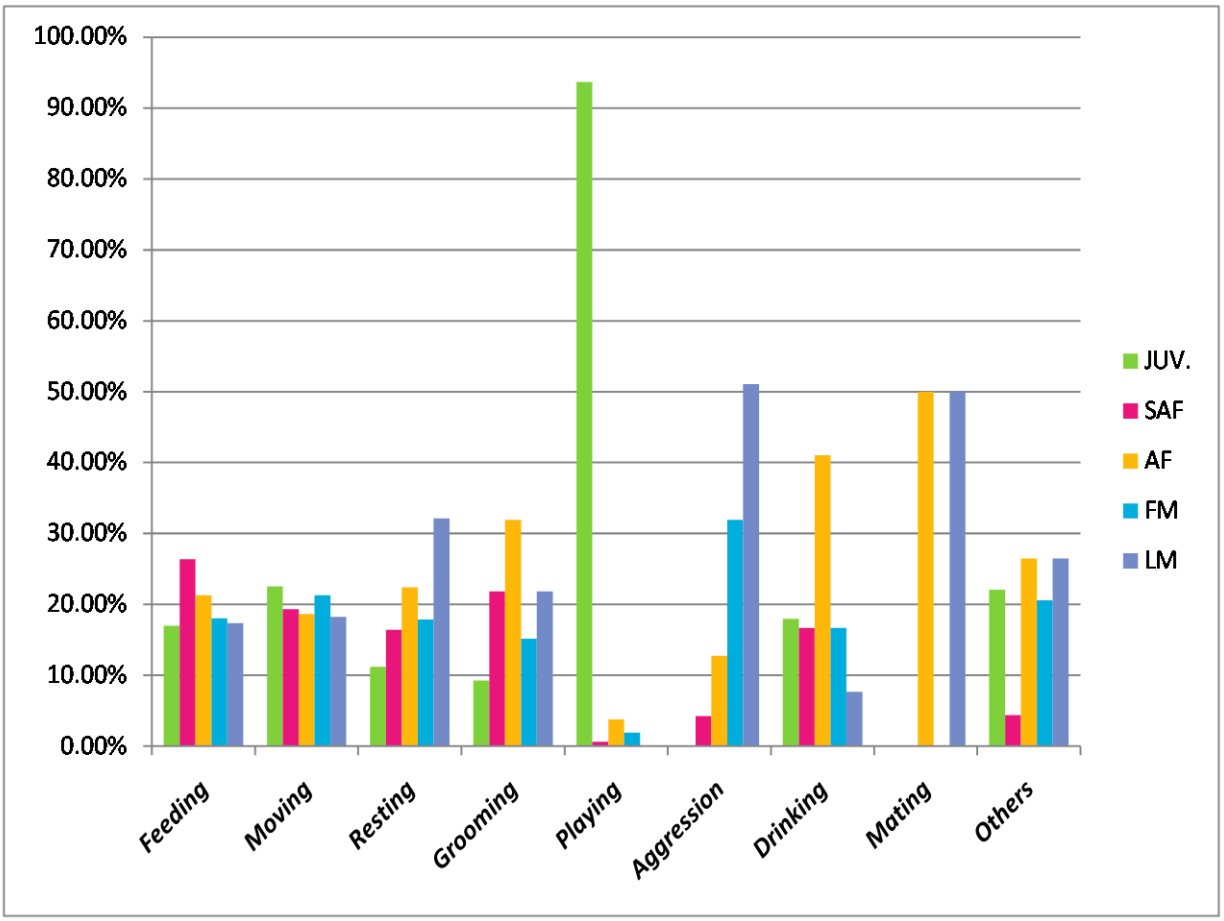


Figure14. Seasonal variation in the activity time budget of OMU of gelada baboons

Variation in the activity time budget of OMUs of geladas based on age and sex categories

Sub-adult females spent more time feeding (26.37%) than adults of both sexes while adult females spent more time feeding (21.28 %) compared to the leader male (17.35%). On the other hand, the leader male spent more time resting (32%). Both adult males and females spent more time feeding than juveniles, where as the juveniles mainly engaged in playing (93.67%). Aggression behavior was predominantly observed in the leader (50%) and follower males (30%) (Fig.15).



(JUV= Juveniles, SAF= sub-adult females, AF=Adult females, FM=Follower males, LM= Leader males)

Figure15. Variation in activity time budget of OMU of gelada baboon based on sex/age categories

Temporal variation in activity patterns of OMUs

Feeding (64.5%), drinking (48.72 %) and moving (45.2%) were dominant in the afternoon while most of the mating (71.88%), grooming (61.34%), resting (61.39%), and playing (54.43%) took place in the morning (Table. 6).

Table 6. Temporal variations in the activity pattern of OMUs

Activities	**Observation time**			**Total (%)**
	Morning (7:00-11:00hrs)	Midday (12:00-14:00hrs)	Afternoon (15:00-18:00hrs)	
Feeding	6.28	29.21	64.51	100
Moving	22.39	32.41	45.20	100
Resting	61.39	15.25	23.36	100
Playing	54.43	17.72	27.85	100
Grooming	61.34	15.13	23.53	100
Aggression	38.30	36.17	25.53	100
Drinking	6.41	44.87	48.72	100
Mating	71.88	9.37	18.75	100
Others	38.24	27.94	33.82	100

Grooming bouts in different age/sex classes of OMU of gelada baboons

In OMU of the gelada baboon adult females (31.93%) were more involved in grooming interaction than the leader male (21.85%). On the other hand, the juveniles were least engaged in grooming interactions (9.24%). Most of the grooming by juveniles (59%), sub-adult females (55.7%) and leader males (88.4%) was directed towards adult females. On the other hand, adult females frequently groomed leader males (38%) and juveniles (28.9%). Follower males exhibited the highest grooming towards each other (58.3%) (Table.7).

Table7. Comparisons of the number of grooming bouts by different age and sex classes of OMUs of gelada baboons.

Age and Sex classes	Grooming bouts (n)	Grooming bouts (%)	Direction of grooming (%):				
			JUV.	SAF	AF	FM	LM
Juveniles	22	9.24	9.09	18.18	59.09	4.55	9.09
Sub adult females	52	21.85	9.62	26.92	55.77	5.77	1.92
Adult females	76	31.93	28.94	9.21	22.37	1.32	38.16
Follower males	36	15.13	11.11	30.56	-	58.33	-
Leader males	52	21.85	1.92	9.62	88.46	-	-

n= number of grooming, JUV= Juveniles, SAF= sub-adult females, AF=Adult females, FM=Follower males, LM= Leader males

Mating and reproductive behaviour

All mother geladas were observed carrying only one infant at a time. Most copulation took place in the morning time (Fig. 16). On the average, a female copulated 1-2 times per day. Only the leader male copulates with the females within the unit and he did not try to mate with females outside their own unit. It was also observed that before copulation usually the females initiate sexual interaction by directing their genital areas towards the leader male and by raising the tail and moved it to one side.

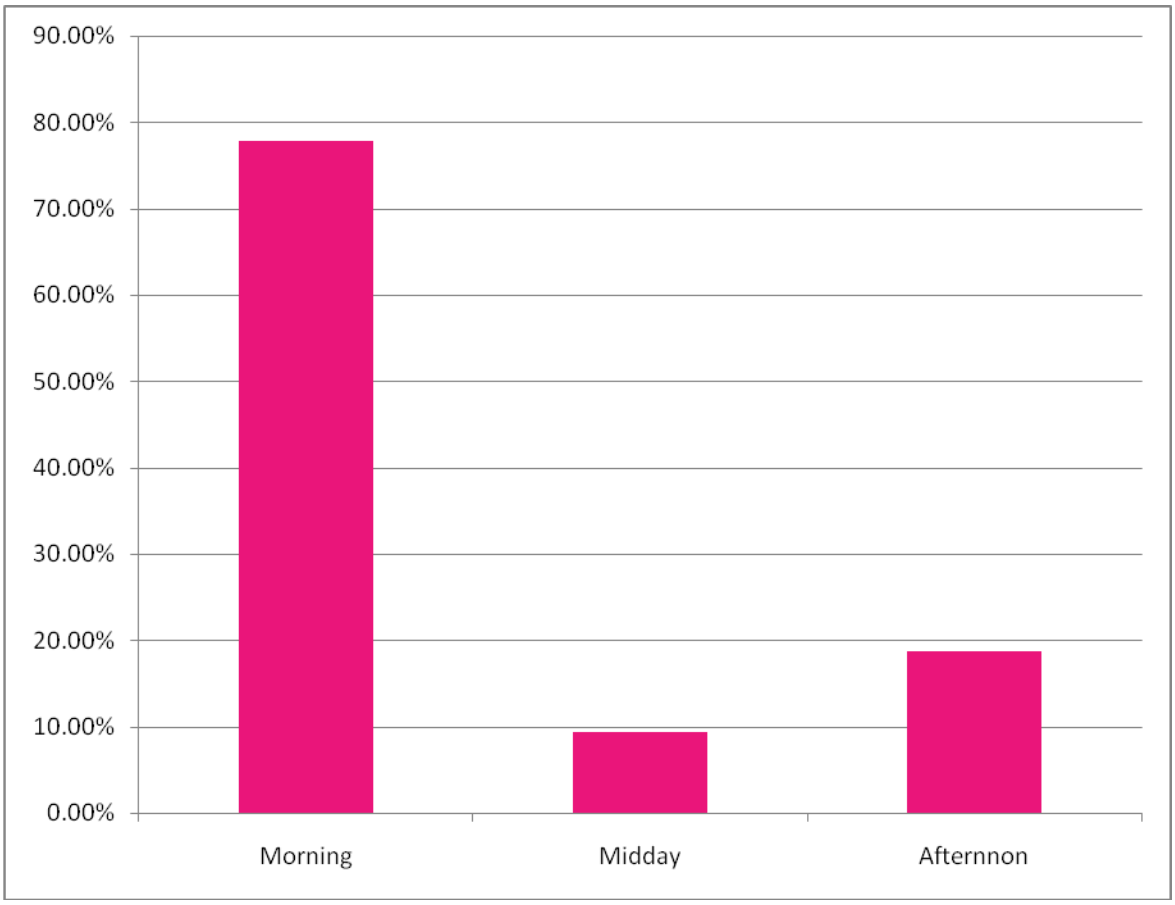


Figure16. Daily variation in copulation time of the OMUs of gelada baboons at GCCA

5.2. All male units

Group size

Group size of AMUs ranged between4-8, while the mean group size was 6.6 individuals (Table 8).

Table 8.Group size of AMUs of gelada baboon

Observation days	1	2	3	4	5	6	7	8	9	10	11	12	**Total**	**Mean**
The number of geladas studied in each day	4	6	4	6	8	8	8	6	8	6	8	8	**80**	**6.6**

The combined activity time budget of the AMU of Gelada baboons

A total of 3937 individual behavioral observations on the various activities of AMUs of gelada baboons were recorded throughout the study period. Feeding (35.03%), moving (27.48%) and resting (16.51%) were the most frequent activities while playing (1.02%) and drinking (1.35%) were the least. The variation in the percentage frequency of the different activity categories was statistically significant (p=0.03) (Fig. 17).

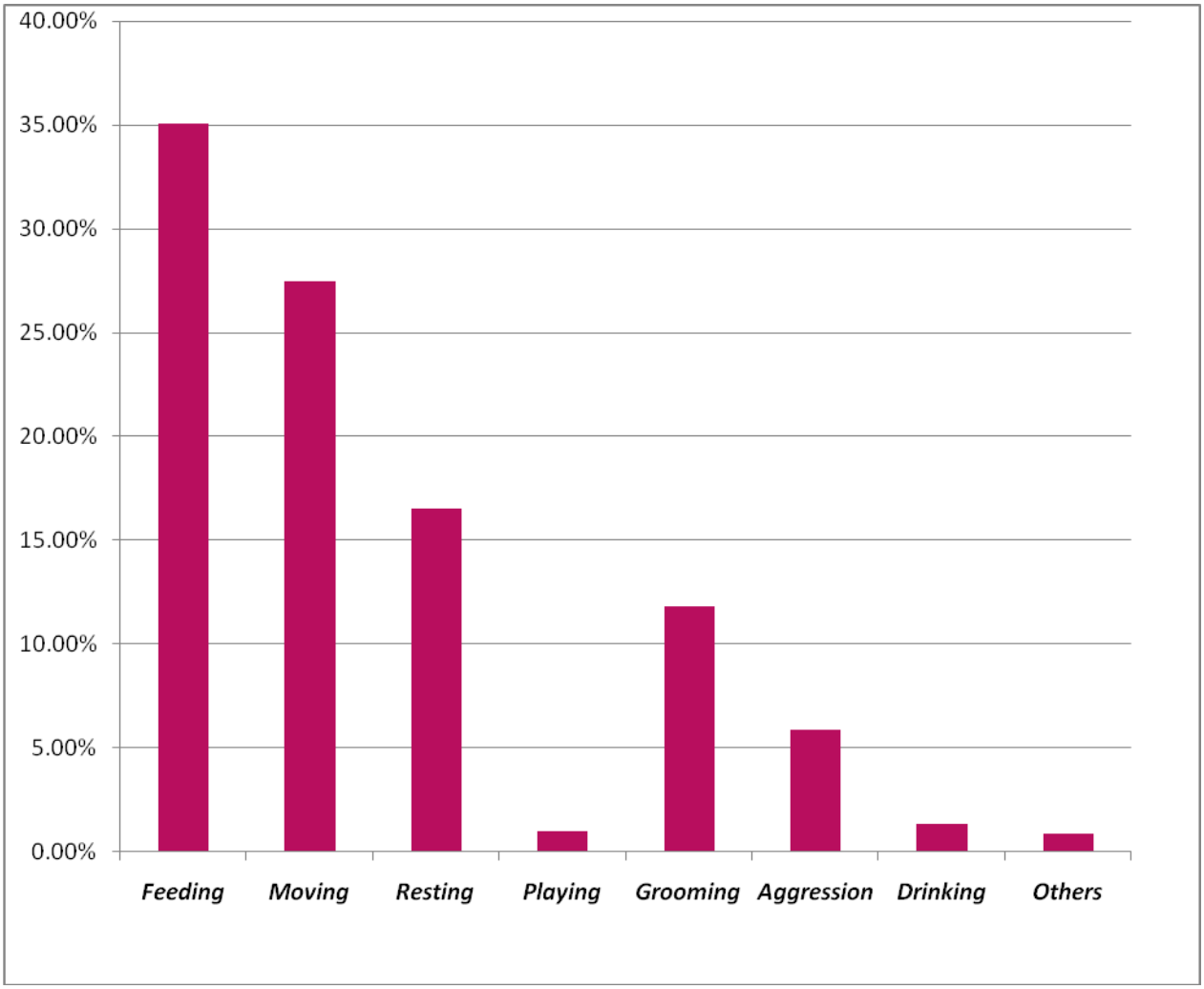


Figure 17.The combined activity time budget of the AMU of gelada baboons at GCCA

Seasonal variation in the activity time budget of AMU of gelada baboons

Feeding (43.33%) and moving (32.19%) were more frequent during the dry season than the wet season while resting (22.58%), grooming (15.13%) and aggression (8.37%) were more frequent during the wet season (Fig. 18).

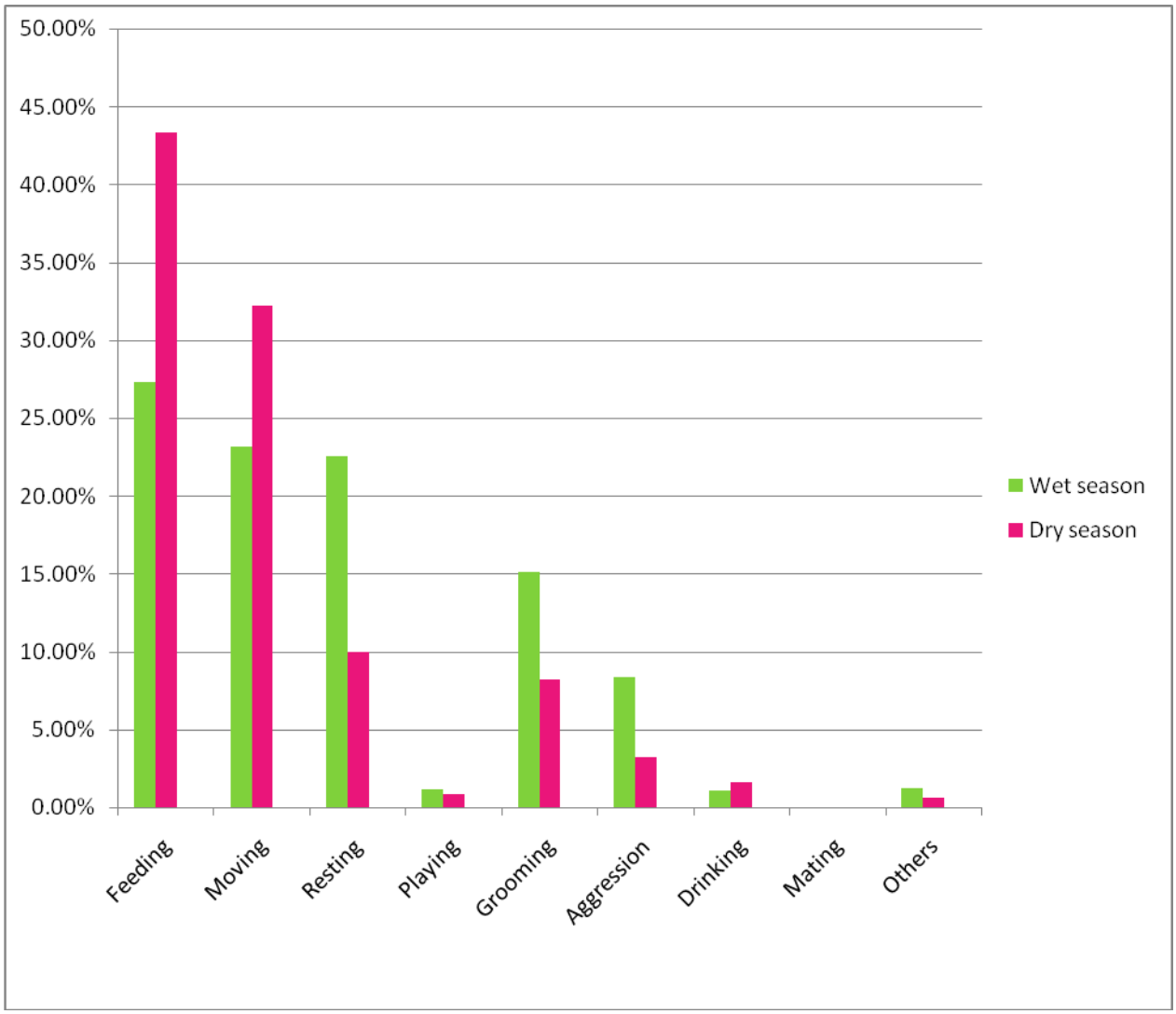


Figure18. Seasonal variation in activity time budget of AMU of gelada baboons at GCCA

Temporal variation in activity time budget of AMU of gelada baboons

Feeding (61.32%), drinking (52.83%) and moving (44.23%) were more frequent during the afternoon while resting (65.85%), grooming (60.65%) and playing (42.50%) were more frequent during the morning (Fig. 19).

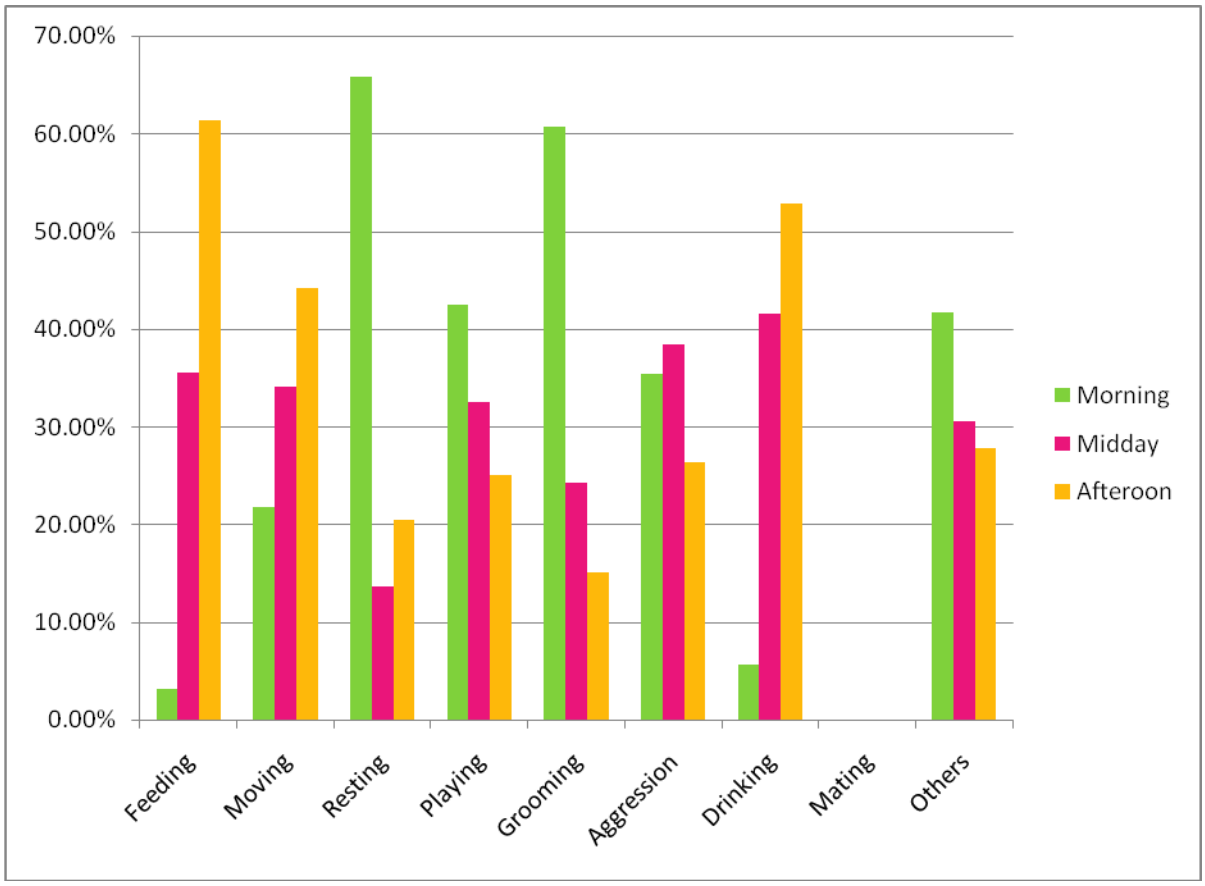


Figure19. The daily activity time budget of AMU of gelada baboons at GCCA

Description of the observed aggression

The leader males in different reproductive units were usually tolerant to each other. In fact the, the leader males from different OMUs cooperate to drive away the bachelor males. Individuals within OMUs travelled close together and OMUs moved close together to other OMUs when the bachelor males approach to them to defend against the bachelor males. However, the bachelor males moved around the reproductive unit to mate with the females. In general the bachelor males are unstable, stealer and more aggressive than the leader males.

5.3. Combined activity time budget of OMUs and AMUs of gelada baboon

A total of 6717 individual behavioral observations on the various activities of the two combined study groups (OMU and AMU) were recorded throughout the study period. Feeding (35.70%), moving (26.83%) and resting (15.93%) were the most frequent activities while playing, aggression, drinking and mating were least frequently observed (<5%) (Fig.20).

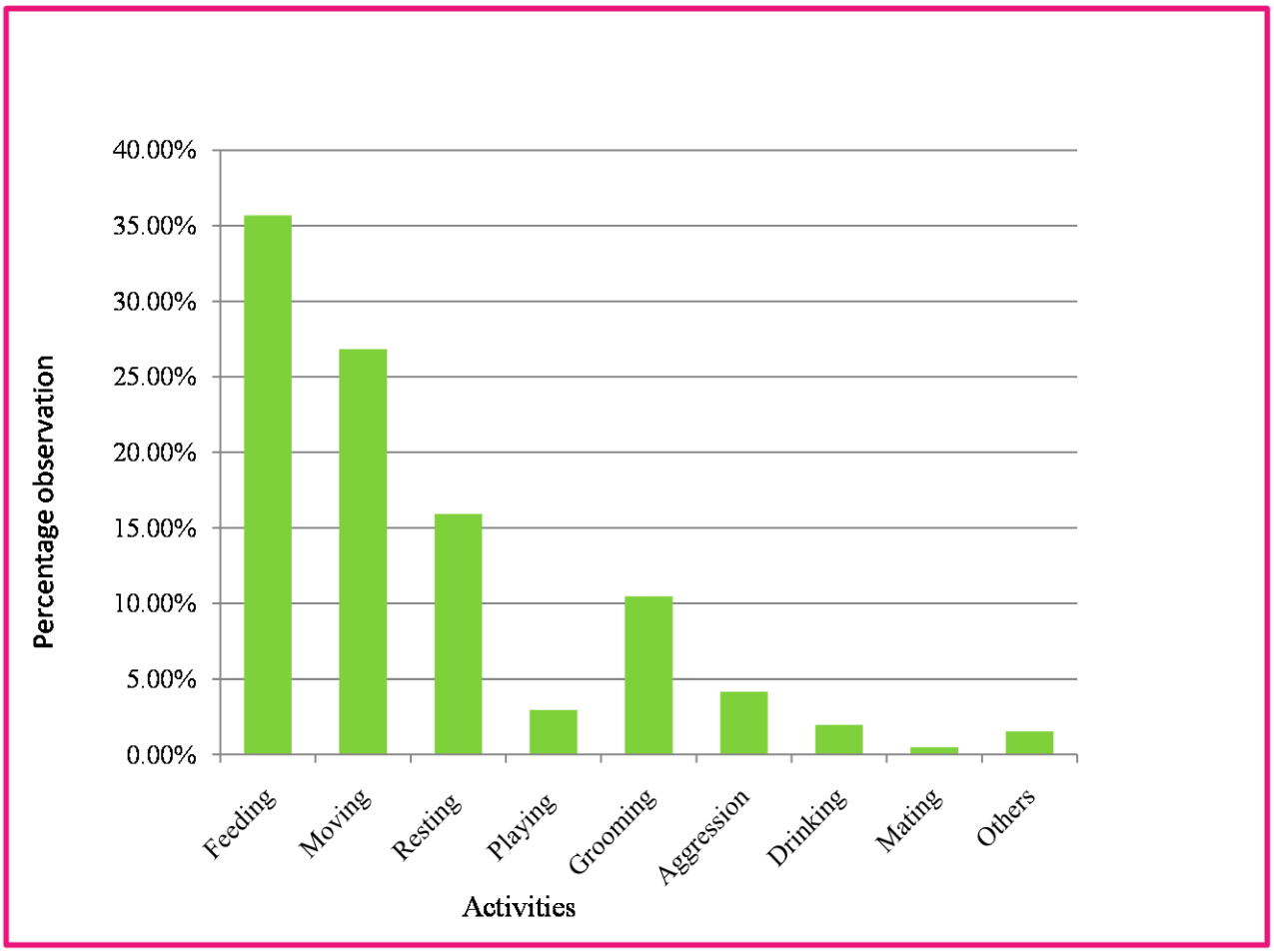


Figure20. The overall activity time budget of the two combined groups of the gelada baboon at GCCA

5.4. Diet composition

A total of 12 species of plants were identified as gelada food items. From the 2,398 feeding records collected from scan sampling of the two combined units of gelada baboons, 79.23 % was spent eating grass blades or leaves. Stems and fruits were the least consumed plant parts (Table. 9).

Table 9. List of plant species and the parts eaten by gelada baboons

No.	Local name	Scientific name	Parts consumed				
			Leaves/blades	Root	Fruits	Seed	Stem
1	**Enjory**	***Rubus apetalus***			**X**	**X**	
2	**Sama**	***Urtica simenisis***		**X**			**X**
3	**Grass**	***Festuca macrophyla***	**X**	**X**		**X**	
4	**Getim**	***Haplocarpha schimperi***	**X**				**X**
5	**Tosign**	***Thymus schimperi***	**X**	**X**			
6	**Kega**	***Rosa abysinica***			**X**	**X**	
7	**Embuacho**	***Rumex nervesus***	**X**	**X**			
8	**Gebis**	***Hordeum vulgare***				**X**	
9	**Yeadayi abeba**	***Adenostema caffrum***	**X**				**X**
10	**Sinde**	***Triticum aestivum***				**X**	
11	**Yemidir Koso**	***Alchemilla abyssinica***	**X**	**X**			
12	**Lut**	***Malva verticillata***	**X**	**X**			

(Data are from scan sampling. X-indicates that geladas was observed feeding on the reproductive parts of the plant).

Seasonal variation in dietary composition of gelada baboons

Short grass blades were the major diet of gelada baboons during both the wet (57%) and dry (49%) season while long grass was secondarily important (30% wet season; 24% dry season). Roots and herb leaves were taken in small amounts (Fig. 21).

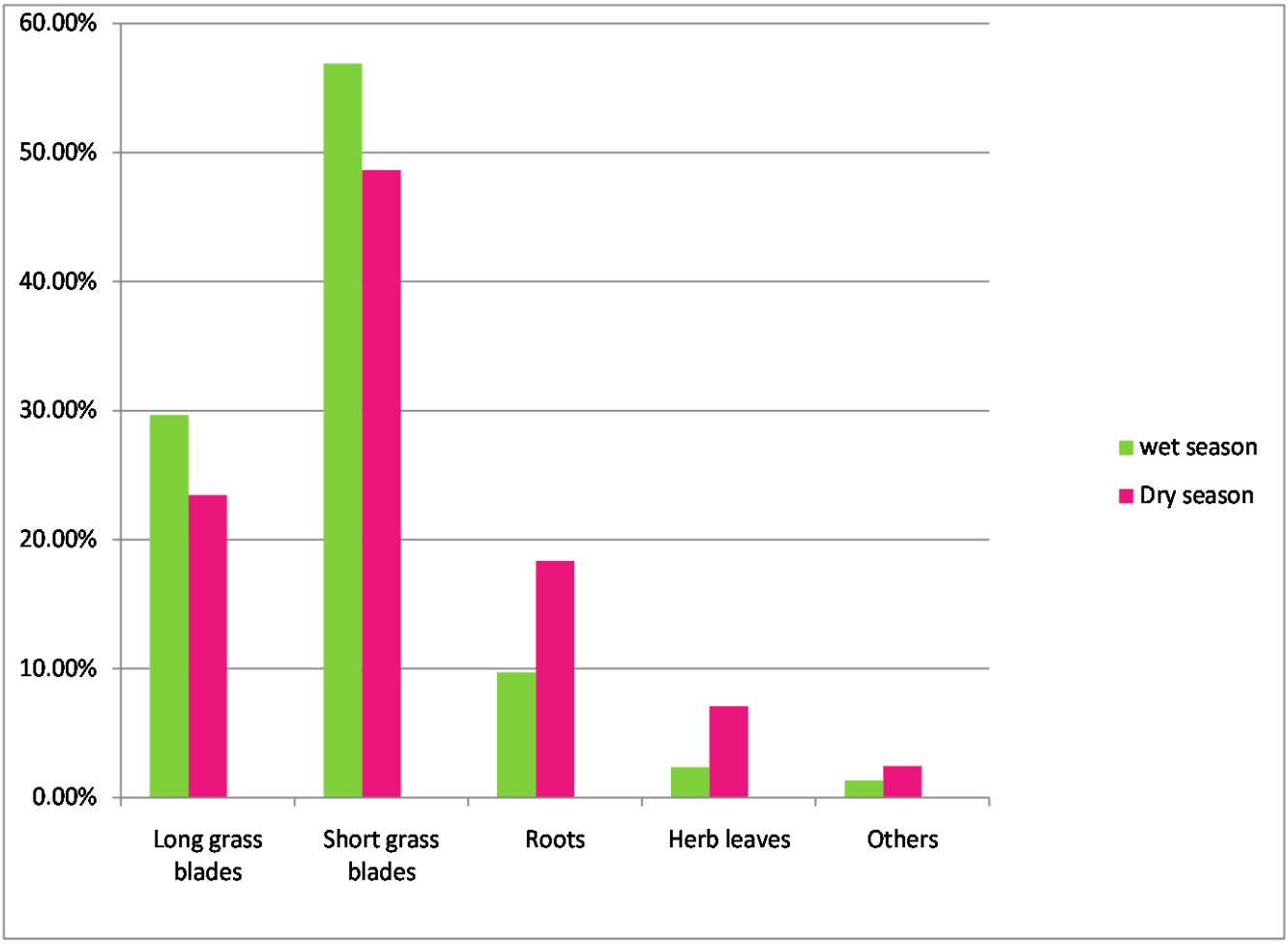


Figure21. Seasonal dietary composition of gelada baboons at GCCA

6. DISCUSSION

The mean OMU size observed in this study (11.25) was comparable with what was reported by Dunbar (1984) at Sankaber (12). The mean number of adult females at Guassa did not deviate from the mean number of adult females determined by Dunbar (1984) at Sankaber, which were 4.12.

Results of the present study suggested that in gelada baboons feeding and moving were the most frequent activities while aggression and mating were the least. Similarly, Kelil Abu (2011) also suggested that even though Arsi gelada baboons are social animals they spend less time for social activities such as mating and aggression. In order to fulfill the energy requirement they spent more time moving and feeding.

Gelada baboons showed seasonal difference in the activity time budget. During the dry season the gelada baboons spent more time feeding and moving than resting and socializing. This may be due to a decline in the quality and quantity of food during the dry season compared with the wet season. Therefore, to satisfy their daily energy requirements they travel more in search of food. On the other hand, the gelada baboons spent relatively more time resting, grooming, playing and mating during the wet season than the dry season. This may be due to the presence of enough food during the wet season than the dry season. These finding is similar to the observation of Dunbar (1992), who indicated that gelada baboons that can obtain food easily spend more time resting and exhibit more social activities such as grooming, mating, playing and aggression than feeding and travelling.

There was also difference in activity time budget between the age and sex classes of the OMUs of gelada baboons. Adult female geladas spent more time feeding than the leader males, which spent more time resting. The increased feeding time in adult females may be due to the extra energy requirements of gestation and lactation. Therefore, to get more energy, they have to consume more food. Similar findings were also reported by Ohsawa (1979), who stated that although adult females are about half the body size of adult males, they spent significantly more time in feeding than adult males, which spent more time resting.

Aggression was restricted to the leader male and follower males. The follower males help the leader male to fight and drive away the bachelor males in order to protect the adult females. This might be to increase reproductive success by the exclusion of the bachelor males as well as other extra-group males.

Members of all age and sex categories spent more time feeding and moving during the dry season than the wet season which was also reported by Dunbar (1992). The gelada baboons also showed temporal variation in their activity time budget. Resting, grooming, and mating were the most frequent activities during the morning. In the morning time the weather at the study area is extremely cold and difficult to move and feed for the gelada baboons. On the other hand, feeding and moving were the most frequent activities in the afternoon than resting and performing social activities. This may be related to the suitable weather in the afternoon for the gelada baboons to feed and travel separately in order to satisfy their energy requirements.

Grooming was exhibited by all members of OMUs of the gelada baboons. Adult females spent more time on grooming than leader males. This might be related with solicitation of copulation, food and protection. Similarly, the leader male spent more time on grooming with the adult females. Smut (1985) noted that high proportion of grooming time investment by dominant male gelada baboons with adult females was to gain acceptance. The leader male was groomed by all members of the unit except the follower males. These findings are also similar with Eshetu Moges (2015).

The observed group size of AMUs showed variation from Gruter and Zinner (2004), who reported a group size of range of 2-15. Members of AMUs exhibited more aggressive behaviour towards non-unit individuals (mostly towards the reproductive units). Similarly, Dunbar (1975) reported that the majority of aggressions were directed outward towards the non-unit individuals.

Short grass blades were the most preferred diet items of gelada in the study area. On the other hand, when the availability of grasses was restricted, they shift their diet to herbs and roots. As reported by Iwamoto (1993), gelada baboons predominately feed on grasses, but during the dry season, when the availability of grass blades decreases, they shift to herbs and roots.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusion

Gelada baboons spent more time through feeding and travelling during the dry season than the wet season. On the other hand, the gelada baboons have long resting and grooming time during the wet season than the dry season. However, throughout the study period feeding, moving and resting were the most frequent activities while playing, aggression and mating were the least frequent observed activities.

Adult female gelada spent more time feeding and travelling than leader males. On the other hand, leader males spent more time resting than foraging and travelling.

Gelada baboons at GCCA mostly feed on grass blades, but if the grasses are not available, they shift to herb leaves and roots.

7.2. Recommendation

The result of the current study indicates that the gelada baboons at the study area feed on a few plant species and mainly they feed on grass blades. However, at present the foraging ecology and habitat of gelada at GCCA are affected by house building, agricultural expansion, fire wood collection and cutting grasses which are the primary diet of gelada baboons. Therefore, the Woreda administrative office should take actions to prevent the expansion of agriculture and settlements near the gelada habitats.

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ANNEX1: Data collection sheet for OMUs of gelada baboons

Date _____

Population Profile:

Sex	*Age categories*	*Number*
Male	*Leader male*	
	Follower males	
Female	*Adult females*	
	Sub adult females	
	Juveniles	
Total number		

Data tables

S. S	*Time*	*Juveniles*	*Sub adult females*	*Adult females*	*Follower males*	*Leader male*
1	*7:00-7:10*					
2	*7:20-7:30*					
3	*7:40-7:50*					
4	*8:00-8:10*					
5	*8:20-8:30*					
6	*8:40-8:50*					
7	*9:00-9:10*					
8	*9:20-9:30*					
9	*9:40-9:50*					
10	*10:00-10:10*					
11	*10:20-10:30*					
12	*10:40-10:50*					
13	*12:00-12:10*					

S. S	Time	Juveniles	Sub adult females	Adult females	Follower males	Leader male
14	12:20-12:30					
15	12:40-12:50					
16	13:00-13:10					
17	13:20-13:30					
18	13:40-13:50					
19	15:00-15:10					
20	15:20-15:30					
21	15:40-15:50					
22	16:00-16:10					
23	16:20-16:30					
24	16:40-16:50					
25	17:00-17:10					
26	17:20-17:30					
27	17:40-17:50					

JUV. **=** *Juvenile,* ***SAF=*** *Sub-adult female****, A.F=*** *Adult female****, L.M=*** *Leader male****, F.M=*** *Follower male*

ANNEX2: Data collection sheet for AMUs of gelada baboons

Date_____

Population profile- Number= _____

Observation time	M1	M2	M_3	M_4	M_5	M6	M7	M8	M9	M10
7:00-7:10 AM										
7:20-7:30AM										
7:40-7:50AM										
8:00-8:10AM										
8:20-8:30AM										
8:40-8:50AM										
9:00-9:10AM										
9:20-9:30AM										
9:40-9:50AM										
10:00-10:10AM										
10:20-10:30AM										
10:40-10:50AM										
12:00-12:10AM										
12:20-12:30AM										
12:40-12:50AM										

Observation time	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
1:00-1:10PM										
1:20-1:30PM										
1:40-1:50PM										
3:00-3:10PM										
3:20-3:30PM										
3:40-3:50PM										
4:00-4:10PM										
4:20-4:30PM										
4:40-4:50PM										
5:00-5:10PM										
5:20-5:30PM										
5:40-5:50PM										

M1= Male 1 M2 = Male 2 M3 = Male3 M4= Male4 M5=Male5 M6=Male6 M7= male7 M8= Male 8 M9=Male 9 M10= Male10

ANNEX3: Data collection sheet for the food item types of gelada

Date_____

No. of observ.	**Type food items**				
	SB	LB	Roots	Herb leaves	Others (Fruits ,Seeds, Flowers ,small animals)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					

SB= Short grass blades, LB= Long grass blades